DOCUMENT RESUME

ED 180 792 SE 029 443

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TITLE The Use of Chronological Age and a Physiological Determinant of Readiness for Formal Arithmetic Computation for First Grade Children.
SPONS AGENCY Tennessee Univ., Knoxville.
PUB DATE 78
NOTE 7p.: Contains occasional light and broken type

EDRS PRICE MF01/PC01 Plus Postage.
DESCRIPTORS *Age: Age Differences: *Arithmetic: Calculation: Conservation (Concept): *Educational Research: Elementary Education: *Elementary School Mathematics: Grade 1: *Learning Readiness: Number Concepts: Physical Characteristics: Physical Development: Readiness: *Readiness (Mental): School Readiness Tests

ABSTRACT

This study was designed to determine whether chronological age, the number of permanent teeth erupted, or the combination of the two would predict a child's readiness for formal arithmetic work. Sixty-four children were randomly chosen and three phases of testing conducted. The findings did not support the use of the number of teeth erupted as a physiological predictor of readiness. Readiness for formal arithmetic computational skills was not judged with any confidence by chronological age. (MK)

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The Use of Chronological Age and a Physiological Determinant of Readiness for Formal Arithmetic Computation for First Grade Children.

(This research was funded by a Faculty Research Grant, University of Tennessee, Knoxville, Tennessee)

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The push in the schools today, especially at the first grade level, is toward establishing readiness for formal arithmetic computation. Readiness for formal arithmetic experiences sets a precedent for learning attitudes toward arithmetic as well as those skills necessary for more complex problem solving and logical thinking in higer mathematics. Because early experiences are crucial, screening procedures are necessary to diagnose when children should be exposed to various arithmetic concepts. It has been suggested by Suydam and Riedesel (1972), Steffe (1966), Copeland (1972) that readiness is tantamount to success of children in the elementary mathematics program.

The fact remains, due to compulsary education, that children will be admitted to the first grade at chronological age six. Coupled with this entrance age is often the use of the standard first grade curriculum including algorithmic work. This assumes children are physical and mentally mature to master arithmetic at seventy-two months.

Olsen and Hughes (1942), Krogman (1972, 1975), Ogletree (1973), and Silvestro (1977) have conjectured that a better means of assessing readiness for school and the types of underlying physiological prerequisites to formal subject matter attainment may be the number of permanent teeth a child may have. The startling fact about the use of the number of teeth erupted, or the concept that if a child had "cut" some permanent teeth then he/she was ready for formal schooling came from the philosophy of the Steiner or Waldorf Schools in the world. Baust (1976) found 83 percent of these schools in the United States used this as either a partial for criteria for readiness for school.

The purpose of the study was to show whether chronological age, the number of permanent teeth erupted, or the combination of the two, would successfully predict a child's readiness on tests of conservation for formal arithmetic work and in terms of the number of correct responses on the Wide Range Achievement Test.

Procedure

A group of sixty-four, caucasoid, first grade boys (32) and girls (32) from a southeastern elementary school were tested in the winter of 1976. The physiological measures involved, control for race was made by choosing only caucasoids, control for socio-economic status was achieved by selecting middle class, while control for age was established in the designation of a first grade group of students. This was done to control the variations of dentitional and physiological patterns of various groups due to genetic and environmental causes.

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Children were chosen randomly and the testing progressed in three stages. Phase I consisted of a Piagetian task, conservation of numbers (Wohlwill & Lowe, 1962); Phase II, the administration of the Wide Range Achievement Test (math segment); Phase III, a photograph was taken of each child's teeth. All phases were carried out successively on one child at a time.

A numerical quantity was given for the conservation of number task where six activities were included. For each activity successfully completed, one point was given, while a wrong response was given zero points and further activities were terminated. The arithmetic segment of the Wide Range Achievement Test, Level I, was used as an assessor of computational ability.

Permanent tooth eruption was narrowed by having two anthropologists check the pictures of the teeth and come to a conclusion on whether 8 specific permanent teeth had pierced the gum, the two front teeth (incisors on the top and bottom jaw), and the two teeth on either side of the incisors, the lateral incisors.

A point accumulated basis was contrived as follows:

0 points if the tooth was a baby (primary tooth)
1 point if a space existed where a baby tooth once was present
2 points if a permanent tooth had broken the gum (gingiva)
3 points if the permanent tooth had reached its final resting place, (occlusal plane)

Bivariate and multiple correlation coefficients were used to test whether a significantly predictive relationship existed between arithmetic computation or conservation of numbers and either chronological age in months, teeth erup ed or both factors combined.

Findings and Discussion

The range of chronological age for all children tested was 77 to 100 months, while the range of teeth erupted was from 0 to a maximal value of 22.0. Table I shows the means, standard deviation, and range of scores for arithmetic computation scores for children, boys, girls.

TABLE I

Source	Mean	S.D.	Range of Scores
Children	21.28	2.96	7-27
Boys	21.00	3.55	
Girls	21.57	2.25	

On the conservation of number the scores ranged from 0, a non-conserver to 5 points which indicated a conserver. Table II shows the means, standard deviation and range of scores for the conservation task for children, boys, girls.

TABLE II

Source	Mean	S.D.
Children	1.68	1.51
Boys	1.84	1.64
Girls	1.5	1.37

Chronological age was found to be significant and positively correlated with arithmetic computation for all of the children and the boys, but not for the girls. Table III and IV show the pertinent results with a regression coefficient with the interesting statistics for the girls in Table V.

TABLE III

C.A. with Arithmetic (66 children)

Source	DF	SS	F	Prob> F	R^2	R
Regression	1	41.09	4.95	0.02	.07	.26
Error	64	530.43				
Corrected Total	65	571.53				

$y_{Arithmetic} = 9.15 + 0.14 \times$ Chronological Age

TABLE IV

C.A. with Arithmetic (33 Boys)

Source	DF	SS	F	Prob> F	R^2	R
Regression	1	72.09	6.73	0.01	.17	.42
Error	31	331.90				
Corrected Total	32	404.00				

$y_{Arithmetic} + 0.10 + 0.24 \times$ Chronological Age

TABLE V

C.A. with Arithmetic (33 Girls)

Source	DF	SS	F	Prob>F	R^2	R
Regression	1	0.07	0.01	0.90	0.0004	.02
Error	31	161.99				
Corrected Toral	32	162.06				

$y_{Arithmetic} + 20.76 + 0.009 \times$ Chronological Age

The correlation for the data are in Table VI.

TABLE VI

Correlation Coefficients

	Arith. Comp.		Conservation Task		*Denotes Significance at .05
Chron. Age	Children	.26*	Children	-.003	
	Boys	.42*	Boys	.01	
	Girls	.02	Girls	-.07	
Tooth Age	Children	.13	Children	-.02	
	Boys	.26	Boys	.05	
	Girls	-.07	Girls	-.16	

The findings cannot support the use of the number of teeth erupted as a physiological readiness predictor nor can one with any confidence judge readiness for formal arithmetic computational skills via chronological age. Though significance was established with boys and the total group when correlating chronological age with arithmetic computation, the girls depart markedly from their counterparts.

A check was made to reestablish whether the arithmetic computation and the conservation of number task scores were correlated. This showed an r of .30**, yet chronological age is significantly correlated with arithmetic computation but related only by chance with the conservation task. This seems to be a curious anomoly that cannot be explained at the present time.

Conclusion and Recommendations

This study looked into the use of readiness based on the conventionally used chronological age as a means assessing readiness for school. Predictiveness of C.A. would seem an erratic value of dubious usefulness and may show a need to

revise either the presentation of formal algorithmic work to children or find another successful means of assessing mathematical readiness.

In addition, the use of the number of teeth erupted, despite current findings by Silvestro (1977) as a predictor of readiness for formal arithmetic work appears unwarrented.

1. The concept of readiness for arithmetic should be looked at more realistically than is now occurring through teaching practices due to the compulsory education laws.

2. Teachers should make judgements based on the use of the conservation of number as a basis for more productive screening for arithmetic readiness as opposed to either chronological age, the number of teeth erupted, or C.A. and T.A.

Careful scrutiny of the means by which teachers or school systems screen, or instruct and select appropriate curricula, children for school and the rigors of subject matter is tantamount to optional achievement and individual growth. Since Silvestro (1977) has found a relationship between reading skills and dentition, further study should be made that looks at the longitudinal population and subpopulations of various races and ancestories; therefore further study of the problem should take place using reading and math scores compared with second dentition. While there needs to be further study on the number of teeth erupted on a larger population more significant work must be done to help teachers diagnose and successfully provide for the needs of the children in their classrooms.

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